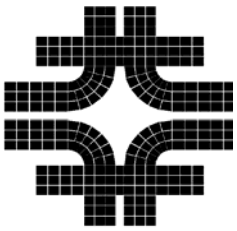

Fermilab

PPD/MD/Engineering Analysis Group

The Effect of Friction Force for a
40 Planes Block (TASD geometry) _ 2

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Introduction

As suggested, a 40 planes FEA model is modified to look into the stress and deflection effect due to the filling process. It is assumed that the structure will be simultaneously [(1)] filled up with 4, 8, 12, 20, 30 and 40 extrusions. The frictional coefficient is assumed to 0.3 cross the bottom. The X is defined as the beam direction. Y is the vertical axis and Z is in its width direction. The result is summarized as following:

1) **Figure 1:** The displacement curves at the bottom of the structure (Y=0). It indicates that the peak of displacement occurs at the end of the filled extrusion and then goes down quickly after that.
2) **Figure 2:**The displacement curve along the beam direction verse its high (Y) at the very last vertical extrusion. It is noted that the displacement peaks at about 40" from the bottom and then comes back to the zero at the top due to the zero pressure.
3) **Figure 3:** The displacement along the beam direction at Y=40.39"(from the bottom).
4) **Figure 4:** The displacement along the beam direction for the case of the 20 planes filled.
5) **Figure 5~Figure 6:** The stress at the last several extrusions for a varieties of cases.

Discussions

There are several things to learn from this study. For the case of a 20 planes, Figure 1 indicates that the displacement at the bottom peaks at X=30" ~ 40" and then decreases to the zero quickly after the several empty extrusions. The bottom of the 39th or 40th extrusion does not move yet as shown in both Figure 1 and Figure 2 (curve for 20 filled planes). One of the interesting question is that what happen with the rest of the structure above the ground (Y>0). How much are they deflected? Does it have an accumulative nature? The Figure 2 and Figure 3 shows that displacement away from the bottom is indeed translated all the way to the last extrusion. There will be ~35 mils displacement at the Y=40" and zero displacement at the Y=0 for the very last extrusion. This ~35 mils is roughly equal to the 10 (pairs)*2 mils/per pair predicted by earlier small FEA mini 3-D model. The displacement of the filled planes is accumulated somewhere along its high, rather than in its bottom. The shape of curve does not change regardless the number of empty extrusion behind it. For the case of a full detector with 2000 planes, if one could fill it up to 1960th planes, the bottom of 2000th plane still does not move due to its friction. The accumulated displacement ~2" (0.002*1960/2) will appear somewhere along its high (Y) at the last several extrusions. This relative displacement within an extrusion will create an additional stress effect. We've plotted the stress at last six extrusions for a variety of the filled cases as shown in Figure 5 through Figure 8. It

indicated that this additional stress ranges from 55 psi for the case of the 4 filled planes to 310 psi for the case of the 30 filled planes. If a full detector is built without any periodic gaps or intermittent stops to cut off this accumulative displacement, this stress could be built up rather quickly, and it will even exceed the operating stress (due to 21 psi). By having several gaps, however, along the beam direction, this complication could be minimized and may also have some positive effect for the relief of the thermal expansion.

Note: (1) A better FEA is still in development stage which will load first several extrusions and run it to get a solution. Then, next loading will be applied at the deformed structure due to the previous loading. It is a difficult model with some technique challenges. We will be working on it if it is needed.

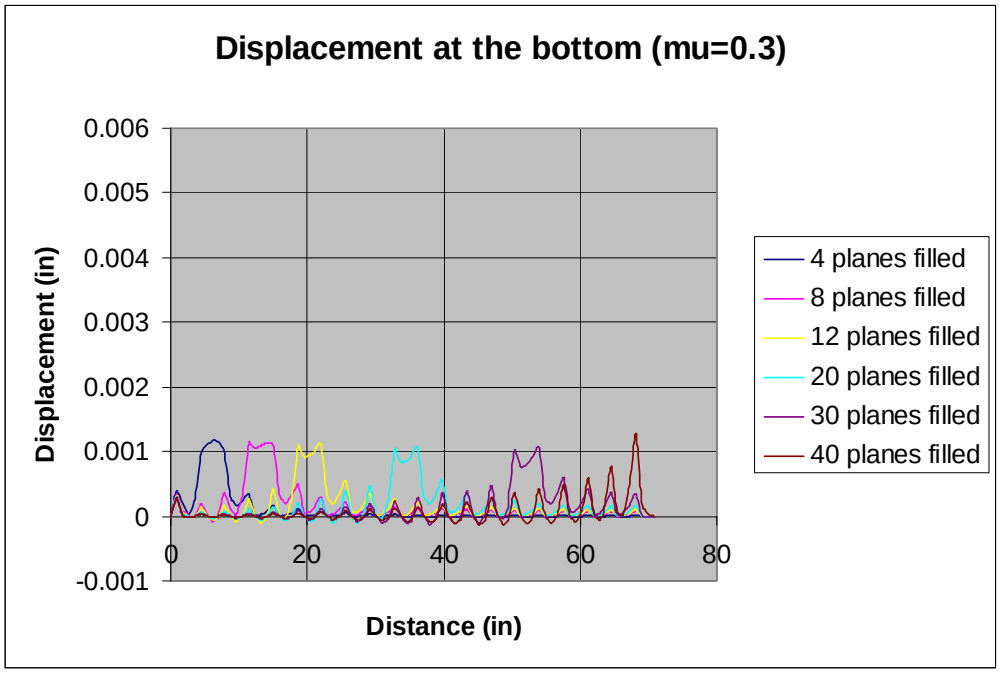


Figure 1 The displacement at the bottom of the extrusion

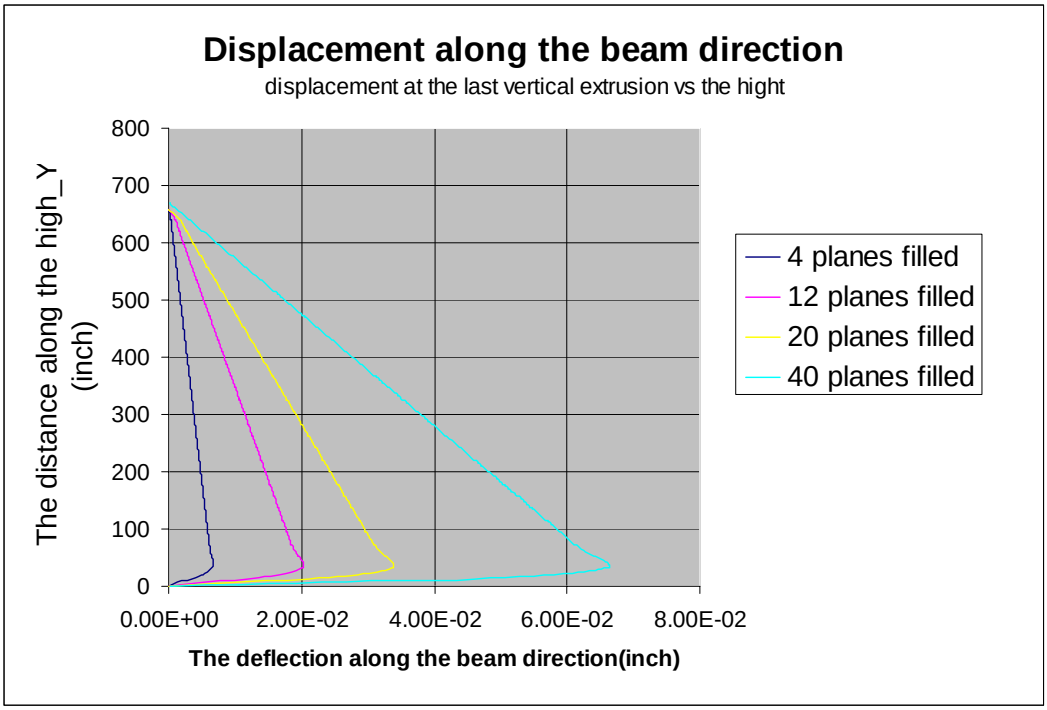


Figure 2 The displacement of 39th extrusion versa its high

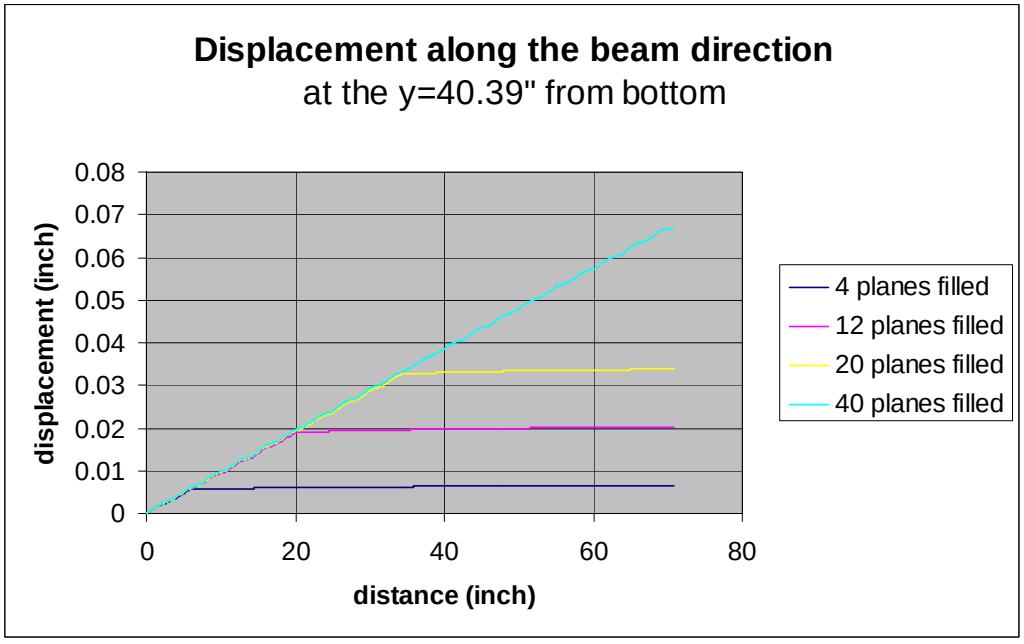
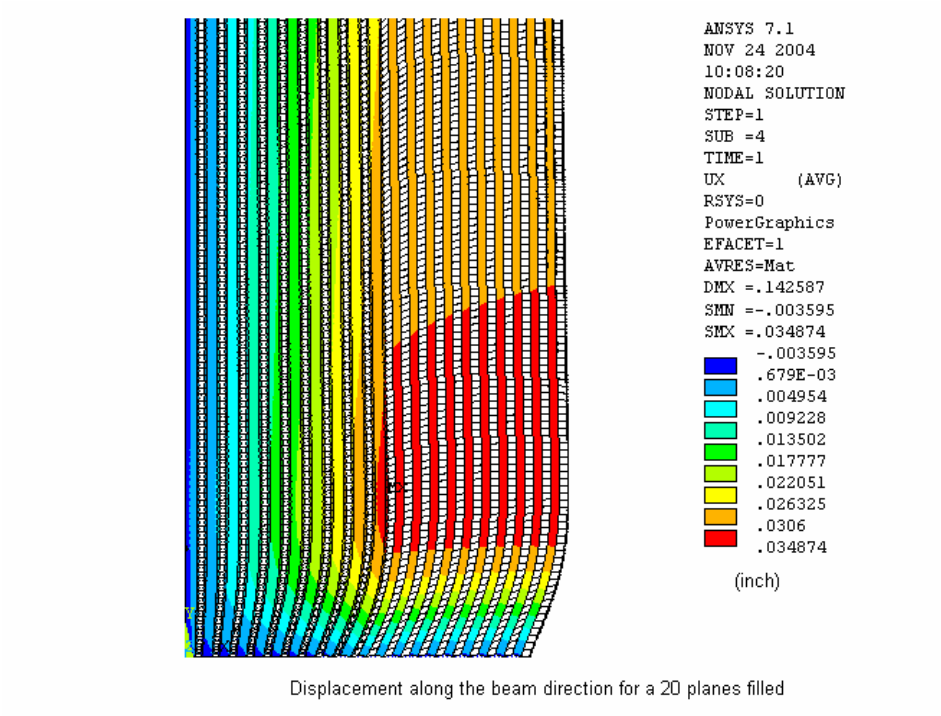


Figure 3 The displacement along the beam direction at Y=40.39”



Displacement along the beam direction for a 20 planes filled

Figure 4 The displacement along the beam direction for a 20 planes filled

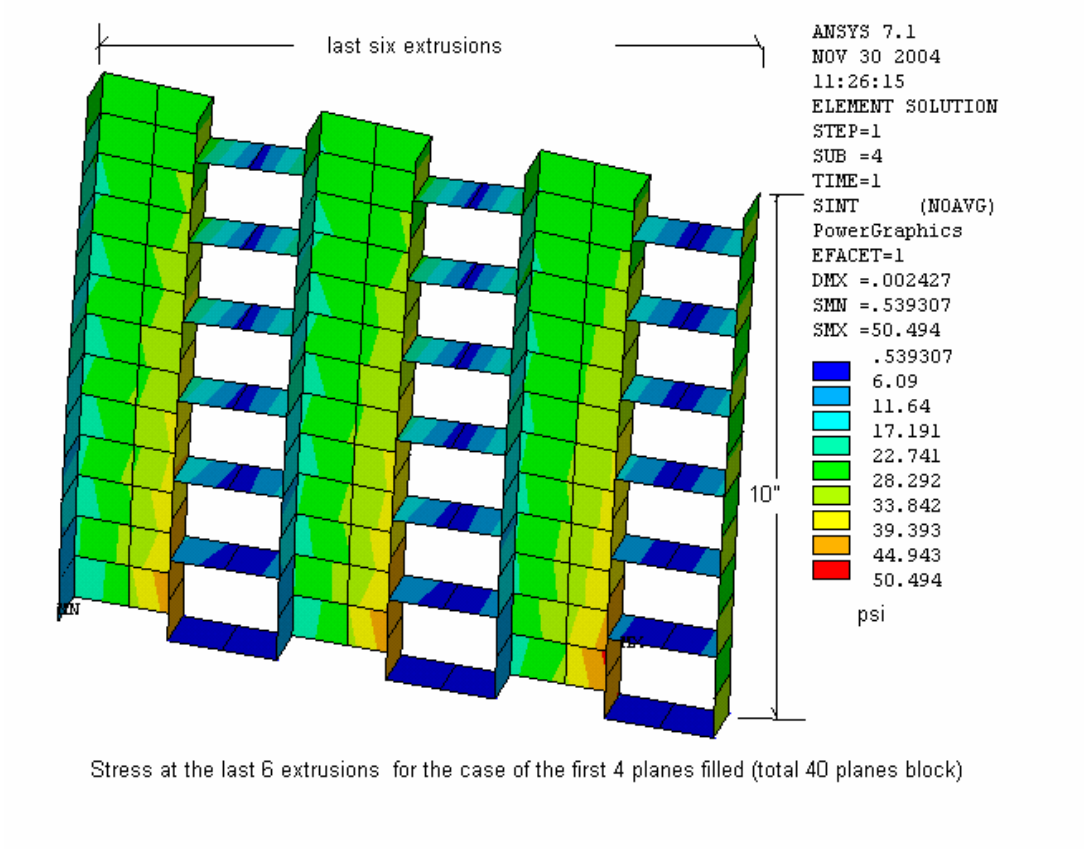
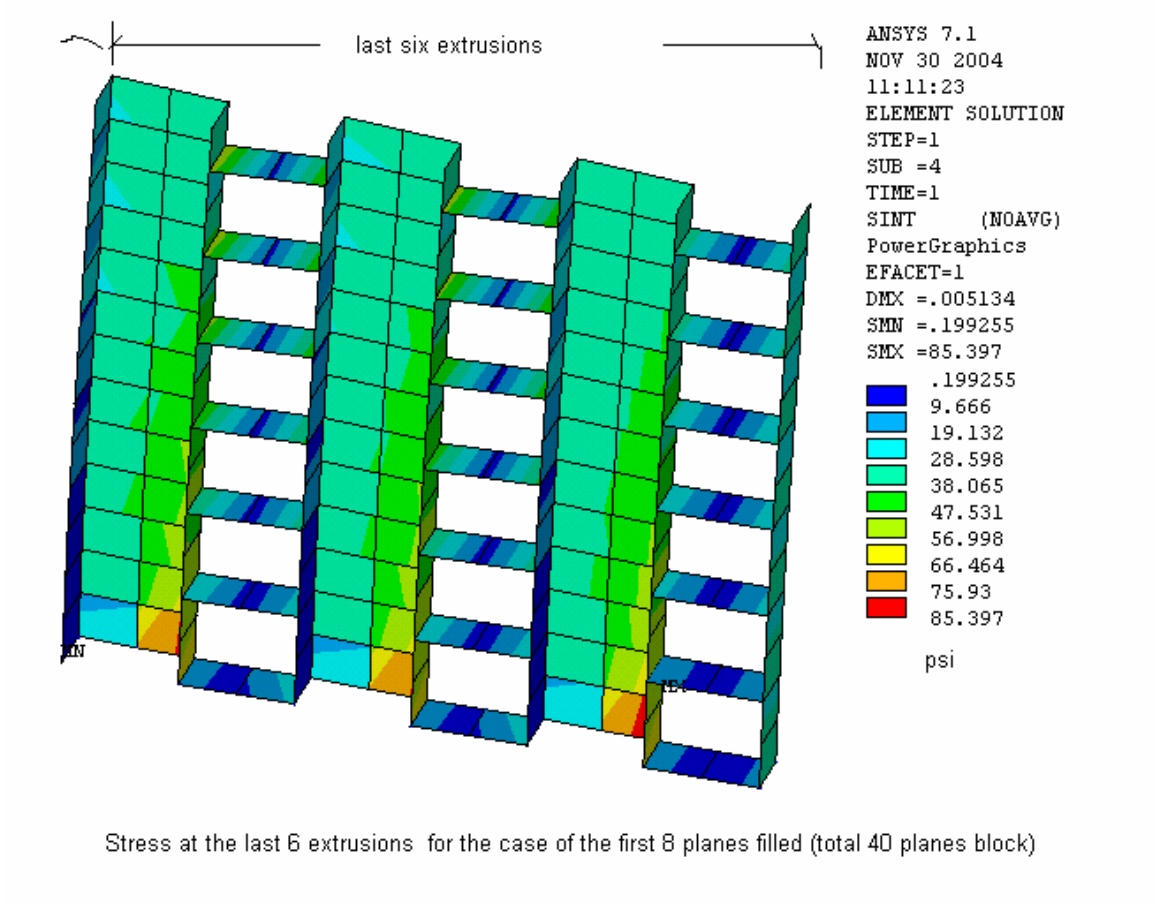


Figure 5 Stress at the last six extrusions for the case of the first 4 planes filled (40 planes block)



Stress at the last 6 extrusions for the case of the first 8 planes filled (total 40 planes block)

Figure 6 Stress at the last six extrusions for the case of the first 8 planes filled (40 planes block)

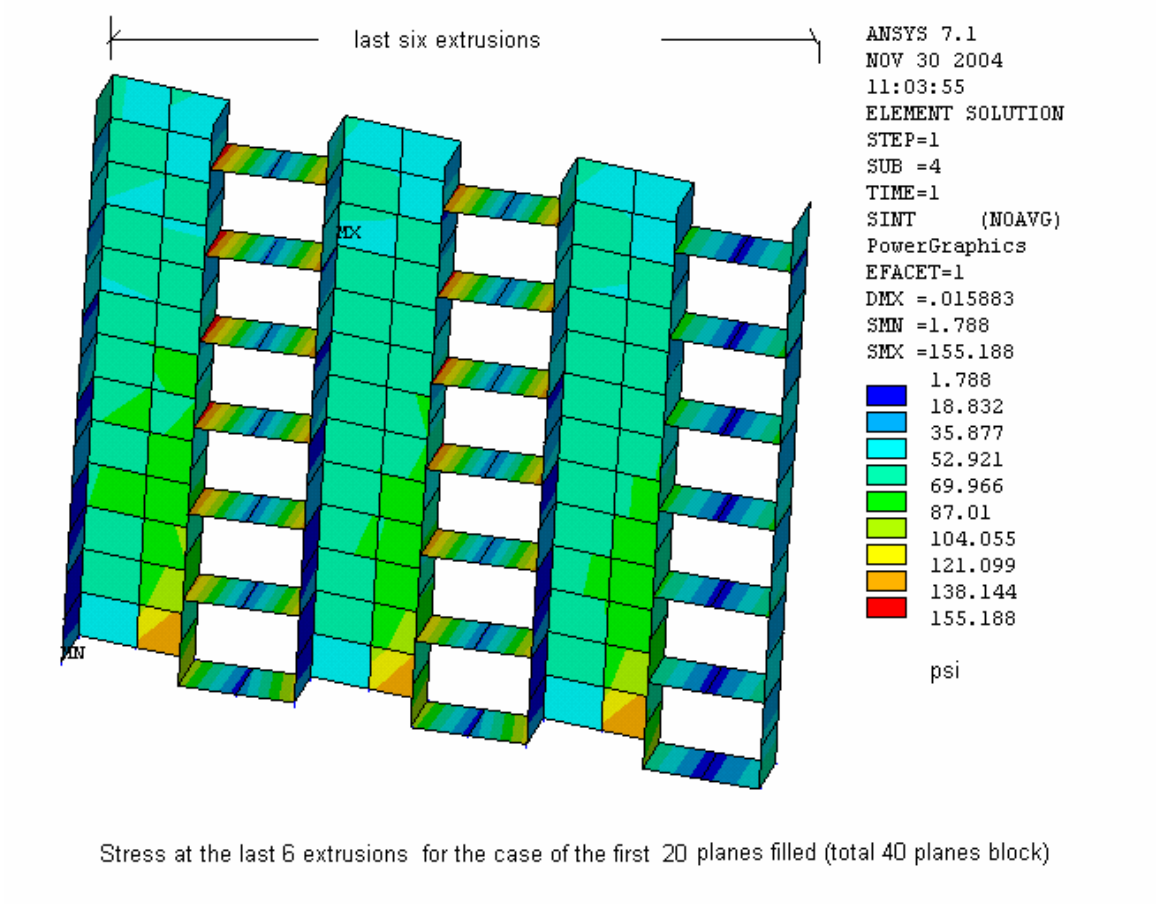


Figure 7 Stress at the last six extrusions for the case of the first 20 planes filled (40 planes block)

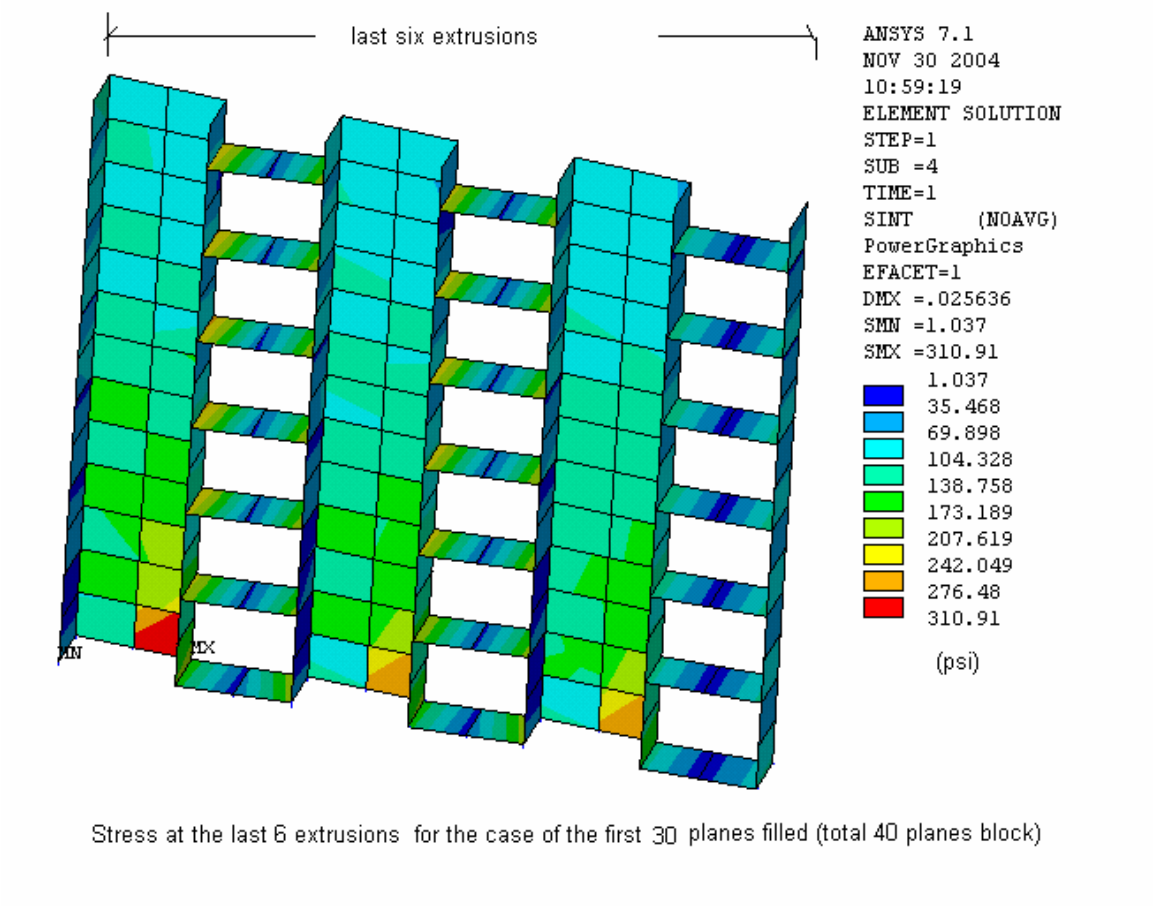


Figure 8 Stress at the last six extrusions for the case of the first 30 planes filled (40 planes block)